

**WE CLAIM:**

1. A common mode linearized input stage, comprising:
  - a differential input terminal  $V_{in+}$ ;
  - a differential input terminal  $V_{in-}$ , said differential input terminals connected to receive a differential input signal;
  - 5 first and second NPN transistors arranged as a differential transistor pair, the bases of said first and second NPN transistors connected to  $V_{in+}$  and  $V_{in-}$ , respectively, the emitters of said first and second NPN transistors connected together at a first node, and the collectors of said first and second NPN transistors conducting respective currents  $I_{D1+}$  and  $I_{D1-}$  in response to said differential input signal;
  - 10 first and second PNP transistors arranged as a differential transistor pair, the bases of said first and second PNP transistors connected to  $V_{in-}$  and  $V_{in+}$ , respectively, the emitters of said first and second PNP transistors connected together at a second node, and the collectors of said first and second PNP transistors conducting respective currents  $I_{D2+}$  and  $I_{D2-}$  in response to said differential input signal;
  - 15 a first tail current source connected to said first node to provide a first tail current  $I_{tail1}$  to said NPN differential transistor pair;
  - 20 a second tail current source connected to said second node to provide a second tail current  $I_{tail2}$  to said PNP differential transistor pair; and
  - 25 a tail current modulation circuit which generates complementary output currents  $I_{in1}$ ,  $I_{in2}$  as a function of the difference between the voltages at said first and second nodes;
  - 30

said first tail current source arranged to generate said first tail current  $I_{tail1}$  as a function of  $I_{in1}$ , and said second tail current source arranged to generate  
35 said second tail current  $I_{tail2}$  as a function of  $I_{in2}$ , said tail current modulation circuit and said first and second tail current sources arranged such that the magnitudes of tail currents  $I_{tail1}$  and  $I_{tail2}$  increase with an increasing differential input signal.

2. The input stage of claim 1, wherein said tail current modulation circuit comprises:

a PNP diversion transistor having its base connected to said first node, its collector coupled to said  
5 first tail current source, and its emitter connected to a third node; and

a NPN diversion transistor having its base connected to said second node, its collector coupled to said second tail current source, and its emitter connected  
10 to said third node,

said PNP and NPN diversion transistors conducting complementary output currents  $I_{in1}$  and  $I_{in2}$ , respectively.

3. The input stage of claim 1, wherein the transistors comprising said NPN and PNP differential transistors pairs each have an emitter size of 1, and said  
5 NPN and PNP diversion transistors each have an emitter size of A, such that, when fully conducting, said PNP and NPN diversion transistors reduce said first and second tail currents by a scaling ratio of A.

4. A common mode linearized input stage, comprising:  
a differential input terminal  $V_{in+}$ ;

a differential input terminal  $V_{in-}$ , said differential input terminals connected to receive a  
5 differential input signal;

first and second NPN transistors arranged as a differential transistor pair, the bases of said first and second NPN transistors connected to  $V_{in+}$  and  $V_{in-}$ , respectively, the emitters of said first and second NPN transistors connected together at a first node, and the collectors of said first and second NPN transistors conducting respective currents  $I_{D1+}$  and  $I_{D1-}$  in response to said differential input signal;

first and second PNP transistors arranged as a differential transistor pair, the bases of said first and second PNP transistors connected to  $V_{in-}$  and  $V_{in+}$ , respectively, the emitters of said first and second PNP transistors connected together at a second node, and the collectors of said first and second PNP transistors conducting respective currents  $I_{D2+}$  and  $I_{D2-}$  in response to said differential input signal;

a first tail current source connected to said first node to provide a first tail current  $I_{tail1}$  to said NPN differential transistor pair;

a second tail current source connected to said second node to provide a second tail current  $I_{tail2}$  to said PNP differential transistor pair;

a PNP diversion transistor having its base connected to said first node, its collector coupled to said first tail current source, and its emitter connected to a third node; and

a NPN diversion transistor having its base connected to said second node, its collector coupled to said second tail current source, and its emitter connected to said third node, such that said PNP and NPN diversion transistors conduct complementary output currents  $I_{in1}$  and  $I_{in2}$ , respectively, as a function of the difference between the voltages at said first and second nodes;

said first tail current source arranged to generate  $I_{tail1}$  as a function of  $I_{in1}$  and said second tail

current source arranged to generate  $I_{tail2}$  as a function of  $I_{in2}$ , such that the magnitudes of  $I_{tail1}$  and  $I_{tail2}$  increase with an increasing differential input signal.

5        5.    The input stage of claim 4, wherein the transistors comprising said NPN and PNP differential transistors pairs each have an emitter size of 1, and said NPN and PNP diversion transistors each have an emitter size  
of A, such that, when fully conducting, said PNP and NPN diversion transistors reduce said first and second tail currents by a scaling ratio of A.

6.    The input stage of claim 5, wherein the values of  $I_{tail1}$  and  $I_{tail2}$  when said PNP and NPN diversion transistors are off are equal to  $I_{1(max)}$  and  $I_{2(max)}$ , respectively, and said input stage is arranged such that the current  $I_{D1+}$   
5    conducted by said first NPN transistor is given by:

$$I_{D1+} = \frac{e^{\alpha}}{e^{\alpha} + A + e^{-\alpha}} * I_{1(max)}$$

the current conducted by said second NPN transistor is given by:

$$I_{D1-} = \frac{e^{-\alpha}}{e^{\alpha} + A + e^{-\alpha}} * I_{1(max)}$$

10    and the current  $I_{div}$  conducted by said PNP and NPN diversion transistors is given by:

$$I_{div} = \frac{A}{e^{\alpha} + A + e^{-\alpha}}$$

where  $\alpha$  is given by:

$$\alpha = \frac{V_{in+} - V_{in-}}{2 * V_t}, \text{ where } V_t \text{ is the thermal voltage } \frac{kT}{q},$$

15    and the transconductance  $G_m$  of the input stage is given by:

$$G_m = \frac{2A * \cosh \alpha + 4}{(2 * \cosh \alpha + A)^2} * \frac{d\alpha}{d(V_{in+} - V_{in-})} * I_{(max)}$$

assuming  $I_{1(max)} = I_{2(max)} = I_{(max)}$ .

7. The input stage of claim 5, wherein the value of A is selected such that  $G_m$  increases with the magnitude of said differential input signal.

8. The input stage of claim 5, wherein the value of A is selected to linearize the response of said NPN and PNP differential transistor pairs.

9. The input stage of claim 5, wherein the value of A is selected to provide a transconductance  $G_m$  for said input stage that decompresses said differential input signal.

10. The input stage of claim 9, further comprising a following stage which receives said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current in response, said following stage having an associated compression characteristic such that said output current does not vary linearly with said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$ , wherein the value of A is selected to provide a transconductance  $G_m$  for said input stage that decompresses said differential input signal so as to compensate for said following stage's compression.

11. The input stage of claim 5, wherein the value of A is at least four.

12. The input stage of claim 4, wherein said first tail current source comprises:

a first fixed current source connected to provide a first output current at a fourth node; and

5 a first bias transistor having its current circuit connected between said first node and said fourth node and biased to conduct at least a portion of said first output current as said first tail current  $I_{tail1}$ , the

collector of said PNP diversion transistor coupled to said  
 10 fourth node such that  $I_{tail1}$  is reduced when said PNP  
 diversion transistor is conducting;

and said second tail current source comprises:

a second fixed current source connected to  
 provide a second output current at a fifth node; and

15 a second bias transistor having its current  
 circuit connected between said second node and said fifth  
 node and biased to conduct at least a portion of said  
 second output current as said second tail current  $I_{tail2}$ , the  
 collector of said NPN diversion transistor coupled to said  
 20 fifth node such that  $I_{tail2}$  is reduced when said NPN  
 diversion transistor is conducting.

13. The input stage of claim 12, wherein said first  
 and second fixed current sources are first and second  
 resistors, respectively.

14. The input stage of claim 4, wherein said first  
 tail current source comprises:

a first fixed current source connected to provide  
 a first output current; and

5 a first current mirror connected to mirror said  
 first output current to said first node such that at least  
 a portion of said first output current is provided as said  
 first tail current  $I_{tail1}$ , said first current mirror  
 comprising:

10 a first diode-connected input transistor  
 connected to receive said first output current, and

a first output transistor having its base  
 connected to the base of said first diode-connected  
 transistor at a fourth node and its emitter connected to  
 15 said first diode-connected transistor's emitter such that  
 said first output current is mirrored to said first node  
 and said first output transistor conducts said first tail

current  $I_{tail1}$ ; and

a second current mirror, comprising:

20 a second diode-connected input transistor coupled to the collector of said PNP diversion transistor, and

a second output transistor connected to mirror the current in said PNP diversion transistor to said fourth node such that  $I_{tail1}$  is reduced when said PNP diversion transistor is conducting; and

said second tail current source comprises:

a third current mirror connected to mirror said first output current to said second node such that at least  
30 a portion of said first output current is provided as said second tail current  $I_{tail2}$ , said third current mirror comprising:

a third diode-connected input transistor connected to receive said first output current, and

35 a third output transistor having its base connected to the base of said third diode-connected transistor at a fifth node and its emitter connected to said third diode-connected transistor's emitter such that said first output current is mirrored to said second node  
40 and said third output transistor conducts said second tail current  $I_{tail2}$ ; and

a fourth current mirror, comprising:

a fourth diode-connected input transistor coupled to the collector of said NPN diversion transistor,  
45 and

a fourth output transistor connected to mirror the current in said NPN diversion transistor to said fifth node such that  $I_{tail2}$  is reduced when said NPN diversion transistor is conducting.

15. The input stage of claim 4, wherein said input stage is arranged such that said PNP and NPN diversion

transistors are off when said input stage is slewing in response to a changing differential input signal.

16. The input stage of claim 4, further comprising a input stage mirroring structure connected between first and second supply voltages and which receives said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current in response, said input stage mirroring structure comprising:
- 5 a first current mirror circuit having an input and output, said differential output currents  $I_{D1+}$  and  $I_{D1-}$  coupled to first current mirror circuit at fourth and fifth nodes, respectively, said first current mirror circuit
  - 10 arranged such that  $I_{D1+}$  and  $I_{D1-}$  inject offset current into an otherwise balanced current mirror such that the current at said first current mirror circuit's output varies only when  $I_{D1+}$  and  $I_{D1-}$  are unequal;
  - a second current mirror circuit having an input
  - 15 and output and complementary to said first current mirror circuit, said differential output currents  $I_{D2+}$  and  $I_{D2-}$  coupled across said second current mirror circuit at sixth and seventh nodes, respectively, said second current mirror circuit arranged such that  $I_{D2+}$  and  $I_{D2-}$  inject offset
  - 20 current into an otherwise balanced current mirror such that the current at said second current mirror circuit's output varies only when  $I_{D2+}$  and  $I_{D2-}$  are unequal;
  - a single floating current source connected
  - between the inputs of said first and second current mirror
  - 25 circuits, the outputs of said first and second current mirror circuits coupled to an output node, the current at said output node being said output current;
  - such that noise due to said floating
  - current source is correlated for the two current mirror
  - 30 circuits such that said noise sums to zero at said output node, said input stage connected to said mirroring structure in a balanced fashion such that a change in  $I_{tail1}$

shifts the voltages at said fourth and fifth nodes by equal amounts and a change in  $I_{tail2}$  shifts the voltages at said  
35 sixth and seventh nodes by equal amounts without changing said output current, thereby rejecting common mode noise.

17. The input stage of claim 16, wherein said floating current source comprises:

an NPN transistor;  
a PNP transistor;  
5 a resistor, the emitter of said NPN transistor connected in series with the emitter of said PNP transistor via said resistor;  
a first reference voltage connected between the bases of said NPN and PNP transistors; and  
10 a second reference voltage connected between ground and the base of said PNP transistor;  
such that said NPN and PNP transistors conduct said bias current  $I_{bias}$ .

18. The input stage of claim 16, further comprising a compensation capacitor connected between said output node and one of said supply voltages.

19. The input stage of claim 16, further comprising a buffer stage connected at its input to said output node and providing a buffered version of said output current at its output.

20. The input stage of claim 16, wherein the transistors comprising said NPN and PNP differential transistor pairs each have an emitter size of 1, and said NPN and PNP diversion transistors each have an emitter size  
5 of A, such that said PNP and NPN diversion transistors conduct and thereby divert said first and second tail currents by a scaling ratio of A when said differential

input signal is zero, wherein the value of A is selected to provide a transconductance  $G_m$  for said input stage that decompresses said differential input signal.

21. The input stage of claim 20, wherein said input stage mirroring structure has an associated compression characteristic such that said output current does not vary linearly with said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$ , wherein the value of A is selected to provide a transconductance  $G_m$  for said input stage that decompresses said differential input signal so as to compensate for said input stage mirroring structure's compression.

22. The input stage of claim 4, further comprising a input stage mirroring structure connected between first and second supply voltages and which receives said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current in response, said input stage mirroring structure comprising:

first and second degeneration resistors connected between said first supply voltage and fourth and fifth nodes, respectively, said currents  $I_{D1+}$  and  $I_{D1-}$  connected to said fourth and fifth nodes, respectively;

third and fourth degeneration resistors connected between said second supply voltage and sixth and seventh nodes, respectively, said currents  $I_{D2+}$  and  $I_{D2-}$  connected to said sixth and seventh nodes, respectively;

a first current mirror connected between said fourth and fifth nodes, comprising:

a first diode-connected input transistor having its emitter connected to said fifth node,

a first current mirror output transistor having its emitter connected to said fourth node, the bases of said first current mirror transistors connected together;

a second current mirror connected between said

sixth and seventh nodes, comprising:

- a second diode-connected input transistor
- 25 having its emitter connected to said sixth node,
- a second current mirror output transistor
- having its emitter connected to said seventh node, the
- bases of said second current mirror transistors connected
- together;
- 30 a bias current source connected between the
- collector of said first current mirror output transistor at
- an eighth node and the collector of said second current
- mirror output transistor at a ninth node;
- an output node;
- 35 a PNP output transistor having its base connected
- to said eighth node, its emitter connected to the collector
- of said first diode-connected input transistor, and its
- collector connected to said output node; and
- a NPN output transistor having its base connected
- 40 to said ninth node, its emitter connected to the collector
- of said second diode-connected input transistor, and its
- collector connected to said output node,
- the current at said output node being said output
- current.

23. The input stage of claim 4, further comprising a
- input stage mirroring structure connected between first and
- second supply voltages and which receives said currents
- $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current  $I_{out}$  in
- 5 response, said input stage mirroring structure comprising:
- first and second degeneration resistors connected
  - between said first supply voltage and fourth and fifth
  - nodes, respectively;
  - third and fourth degeneration resistors connected
  - 10 between said second supply voltage and sixth and seventh
  - nodes, respectively;
  - a first current mirror circuit connected between

said fourth and fifth nodes, comprising:

15           a first diode-connected input transistor  
having its emitter connected to said fifth node,

          a first current mirror output transistor  
having its emitter connected to said fourth node, the bases  
of said first current mirror transistors connected  
together;

20           a second current mirror connected between said  
sixth and seventh nodes, comprising:

          a second diode-connected input transistor  
having its emitter connected to said sixth node,

          a second current mirror output transistor  
25   having its emitter connected to said seventh node, the  
bases of said second current mirror transistors connected  
together;

          a third diode-connected transistor having its  
emitter connected to the collector of said first current  
30   mirror output transistor at an eighth node and its base and  
collector connected together;

          a fourth diode-connected transistor having its  
emitter connected to the collector of said second current  
mirror output transistor at a ninth node and its base and  
35   collector connected together;

          a bias current source connected between the  
collector of said third diode-connected transistor and the  
collector of said fourth diode-connected transistor;

          an output node;

40           a PNP output transistor having its base connected  
to the base and collector of said third diode-connected  
transistor, its emitter connected to the collector of said  
first diode-connected input transistor at a tenth node, and  
its collector connected to said output node; and

45           a NPN output transistor having its base connected  
to the base and collector of said fourth diode-connected  
transistor, its emitter connected to the collector of said

second diode-connected input transistor at an eleventh node, and its collector connected to said output node;

50           said currents  $I_{D1+}$  and  $I_{D1-}$  connected to said eighth and tenth nodes, respectively;

          said currents  $I_{D2+}$  and  $I_{D2-}$  connected to said eleventh and ninth nodes, respectively;

          the current at said output node being said output  
55   current, said input stage mirroring structure arranged such that  $I_{out}$  is given by:

$$I_{out} = I_{D2+} + I_{D1+} - I_{D2-} - I_{D1-}.$$

24. A common mode linearized input stage, comprising:

          a differential input terminal  $V_{in+}$ ,

          a differential input terminal  $V_{in-}$ , said differential input terminals connected to receive a  
5   differential input signal;

          first and second NPN transistors arranged as a differential transistor pair, the bases of said first and second NPN transistors connected to  $V_{in+}$  and  $V_{in-}$ , respectively, the emitters of said first and second NPN  
10   transistors connected together at a first node, and the collectors of said first and second NPN transistors conducting respective currents  $I_{D1+}$  and  $I_{D1-}$  in response to said differential input signal;

          first and second PNP transistors arranged as a  
15   differential transistor pair, the bases of said first and second PNP transistors connected to  $V_{in-}$  and  $V_{in+}$ , respectively, the emitters of said first and second PNP transistors connected together at a second node, and the collectors of said first and second PNP transistors  
20   conducting respective currents  $I_{D2+}$  and  $I_{D2-}$  in response to said differential input signal,

          said first and second NPN transistors and said first and second PNP transistors each having an emitter size of 1;

25 a first tail current source connected to said first node to provide a first tail current  $I_{tail1}$  to said NPN differential transistor pair;

a second tail current source connected to said second node to provide a second tail current  $I_{tail2}$  to said  
30 PNP differential transistor pair;

a PNP diversion transistor having its base connected to said first node, its collector coupled to said first tail current source, and its emitter connected to a third node; and

35 a NPN diversion transistor having its base connected to said second node, its collector coupled to said second tail current source, and its emitter connected to said third node, said PNP and NPN diversion transistors each having an emitter size of A,

40 such that said PNP and NPN diversion transistors conduct and thereby divert said first and second tail currents from said NPN and PNP differential transistor pairs by a scaling ratio of A when said differential input signal is zero;

45 said input stage arranged such that the current  $I_{D1+}$  conducted by said first NPN transistor is given by:

$$I_{D1+} = \frac{e^{\alpha}}{e^{\alpha} + A + e^{-\alpha}} * I_{l(max)}$$

the current conducted by said second NPN transistor is given by:

50 
$$I_{D1-} = \frac{e^{-\alpha}}{e^{\alpha} + A + e^{-\alpha}} * I_{l(max)}$$

and the current  $I_{div}$  conducted by said PNP and NPN diversion transistors is given by:

$$I_{div} = \frac{A}{e^{\alpha} + A + e^{-\alpha}}$$

where  $\alpha$  is given by:

55  $\alpha = \frac{V_{in+} - V_{in-}}{2 * V_t}$ , where  $V_t$  is the thermal voltage  $\frac{kT}{q}$ ,

and the transconductance  $G_m$  of the input stage is given by:

$$G_m = \frac{2A * \cosh \alpha + 4}{(2 * \cosh \alpha + A)^2} \cdot \frac{d\alpha}{d(V_{in+} - V_{in-})} \cdot I_{(max)}$$

assuming  $I_{1(max)} = I_{2(max)} = I_{(max)}$ .

25. The input stage of claim 24, further comprising a input stage mirroring structure connected between first and second supply voltages and which receives said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current in
- 5 response, said input stage mirroring structure comprising:
- first and second degeneration resistors connected between said first supply voltage and fourth and fifth nodes, respectively, said currents  $I_{D1+}$  and  $I_{D1-}$  connected to said fourth and fifth nodes, respectively;
  - 10 third and fourth degeneration resistors connected between said second supply voltage and sixth and seventh nodes, respectively, said currents  $I_{D2+}$  and  $I_{D2-}$  connected to said sixth and seventh nodes, respectively;
  - a first current mirror connected between said
  - 15 fourth and fifth nodes, comprising:
    - a first diode-connected input transistor having its emitter connected to said fifth node,
    - a first current mirror output transistor having its emitter connected to said fourth node, the bases
    - 20 of said first current mirror transistors connected together;
    - a second current mirror connected between said sixth and seventh nodes, comprising:
      - a second diode-connected input transistor
      - 25 having its emitter connected to said sixth node,
      - a second current mirror output transistor having its emitter connected to said seventh node, the

bases of said second current mirror transistors connected together;

30           a bias current source connected between the collector of said first output transistor at an eighth node and the collector of said second output transistor at a ninth node;

          an output node;

35           a PNP output transistor having its base connected to said eighth node, its emitter connected to the collector of said first diode-connected input transistor, and its collector connected to said output node; and

40           a NPN output transistor having its base connected to said ninth node, its emitter connected to the collector of said second diode-connected input transistor, and its collector connected to said output node,

          the current at said output node being said output current.

26. The input stage of claim 25, wherein said input stage mirroring structure has an associated compression characteristic such that said output current does not vary linearly with said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$ , wherein  
5 the value of A is selected to provide a transconductance  $G_m$  for said input stage that decompresses said differential input signal so as to compensate for said input stage mirroring structure's compression.

27. A common mode linearized input stage, comprising:  
first and second supply voltages;  
a differential input terminal  $V_{in+}$ ;  
a differential input terminal  $V_{in-}$ , said  
5 differential input terminals connected to receive a differential input signal;

first and second NPN transistors arranged as a differential transistor pair, the bases of said first and

second NPN transistors connected to  $V_{in+}$  and  $V_{in-}$ ,  
10 respectively, the emitters of said first and second NPN transistors connected together at a first node, and the collectors of said first and second NPN transistors conducting respective currents in response to said differential input signal;

15 first and second PNP transistors arranged as a differential transistor pair, the bases of said first and second PNP transistors connected to  $V_{in-}$  and  $V_{in+}$ , respectively, the emitters of said first and second PNP transistors connected together at a second node, and the  
20 collectors of said first and second PNP transistors coupled to said second supply voltage;

a first tail current source connected between said first node and said second supply voltage to provide a first tail current  $I_{tail1}$  to said NPN differential transistor  
25 pair;

a second tail current source connected between said first supply voltage and said second node to provide a second tail current  $I_{tail2}$  to said PNP differential transistor pair;

30 a PNP diversion transistor having its base connected to said first node, its collector coupled to said first tail current source, and its emitter connected to a third node; and

a NPN diversion transistor having its base  
35 connected to said second node, its collector coupled to said first supply voltage, and its emitter connected to said third node,

such that said PNP and NPN diversion transistors conduct and thereby divert said first tail current from  
40 said NPN differential transistor pair when said differential input signal is zero.

28. An amplifier, comprising:

an input stage; and  
 an input stage mirroring structure;  
 said input stage comprising:

- 5           a differential input terminal  $V_{in+}$ ;  
           a differential input terminal  $V_{in-}$ , said  
 differential input terminals connected to receive a  
 differential input signal;  
           first and second NPN transistors arranged as  
 10 a differential transistor pair, the bases of said first and  
 second NPN transistors connected to  $V_{in+}$  and  $V_{in-}$ ,  
 respectively, the emitters of said first and second NPN  
 transistors connected together at a first node, and the  
 collectors of said first and second NPN transistors  
 15 conducting respective currents  $I_{D1+}$  and  $I_{D1-}$  in response to  
 said differential input signal;  
           first and second PNP transistors arranged as  
 a differential transistor pair, the bases of said first and  
 second PNP transistors connected to  $V_{in-}$  and  $V_{in+}$ ,  
 20 respectively, the emitters of said first and second PNP  
 transistors connected together at a second node, and the  
 collectors of said first and second PNP transistors  
 conducting respective currents  $I_{D2+}$  and  $I_{D2-}$  in response to  
 said differential input signal;  
 25           a first tail current source connected to  
 said first node to provide a first tail current  $I_{tail1}$  to  
 said NPN differential transistor pair;  
           a second tail current source connected to  
 said second node to provide a second tail current  $I_{tail2}$  to  
 30 said PNP differential transistor pair;  
           a tail current modulation circuit which  
 generates complementary output currents  $I_{in1}$ ,  $I_{in2}$  as a  
 function of the difference between the voltages at said  
 first and second nodes;  
 35           said first tail current source arranged to  
 generate said first tail current  $I_{tail1}$  as a function of  $I_{in1}$ ,

and said second tail current source arranged to generate said second tail current  $I_{tail2}$  as a function of  $I_{in2}$ , said tail current modulation circuit and said first and second  
 40 tail current sources arranged such that the magnitudes of tail currents  $I_{tail1}$  and  $I_{tail2}$  increase with an increasing differential input signal;

said input stage mirroring structure connected between first and second supply voltages and which receives  
 45 said currents  $I_{D1+}$ ,  $I_{D1-}$ ,  $I_{D2+}$  and  $I_{D2-}$  and produces an output current in response, said input stage mirroring structure comprising:

a first current mirror circuit having an input and output, said differential output currents  $I_{D1+}$  and  
 50  $I_{D1-}$  coupled to first current mirror circuit at third and fourth nodes, respectively, said first current mirror circuit arranged such that  $I_{D1+}$  and  $I_{D1-}$  inject offset current into an otherwise balanced current mirror such that the current at said first current mirror circuit's output  
 55 varies only when  $I_{D1+}$  and  $I_{D1-}$  are unequal;

a second current mirror circuit having an input and output and complementary to said first current mirror circuit, said differential output currents  $I_{D2+}$  and  
 60  $I_{D2-}$  coupled to second current mirror circuit at fifth and sixth nodes, respectively, said second current mirror circuit arranged such that  $I_{D2+}$  and  $I_{D2-}$  inject offset current into an otherwise balanced current mirror such that the current at said second current mirror circuit's output varies only when  $I_{D2+}$  and  $I_{D2-}$  are unequal;

65 a single floating current source connected between the inputs of said first and second current mirror circuits, the outputs of said first and second current mirror circuits coupled to an output node, the current at said output node being said output current;

70 such that noise due to said floating current source is correlated for the two current mirror

circuits such that its noise sums to zero at said output node, said input stage connected to said mirroring structure in a balanced fashion such that a change in  $I_{tail1}$  shifts the voltages at said third and fourth nodes by equal amounts and a change in  $I_{tail2}$  shifts the voltages at said fifth and sixth nodes by equal amounts without changing said output current, thereby rejecting common mode noise.